COOLING SUIT

TECHNICAL FIELD

[0001] The present invention relates to a cooling suit configured to cool a wearer's body by causing outside air to flow along the wearer's body parallelly thereto.

BACKGROUND ART

[0002] It is possible to regard a human as an extremely inefficient working device which ingests food to conduct life support activities, pieces of work, and the like, and to generate heat commensurately therewith. Due to the inefficiency, most of caloric intake is turned into heat, thereby requiring radiation of a large amount of heat commensurating with a then quantity of work in order to keep a normal body temperature. To this end, humans each possesses a physiological ability for cooling his/her body by virtue of perspiration. Namely, there is determined a physiologically required quantity of heat radiation commensurately with a quantity of work, and perspiration is exuded commensurately therewith, in a manner to attain heat radiation which is most suitable for the then situation of him/her when the perspiration is fully evaporated. Naturally, the amount of perspiration commensurating with the quantity of heat radiation will not be unequivocally calculated by his/her brain. Nonetheless, drastically

raised body temperatures lead to large amounts of perspiration to be continuously exuded, and resultingly lowered body temperatures lead to reduced amounts of perspiration, so that the body is not excessively cooled. As such, there is resultingly exuded an amount of perspiration commensurately with a required quantity of heat radiation.

[0003] However, it becomes impossible to obtain a required quantity of heat radiation when vaporization of perspiration is disabled depending on conditions of temperature, humidity, presence/absence of airstreams, quantity of work, and the like, such that perspiration is continuously and uselessly exuded in a liquid state without vaporization, thereby causing not only uncomfortableness but also physiological damages. As such, there is required aid of a cooling suit. Among cooling suits, the cooling suit (hereinafter also called "air-flow type cooling suit") of a type configured to cool a wearer's body by causing outside air to flow along the wearer's body parallelly thereto, cools the wearer's body by utilizing outside air without using a cooling device such as a compressor, thereby enabling achievement of mild cooling of the wearer's body at a reduced power consumption.

[0004] Patent-related reference 1: International Publication WO 02/067708 pamphlet

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005] Incidentally, conventional air-flow type cooling suits are each capable of evaporating perspiration exuded during conduction of a normal work of a wearer, thereby enabling the wearer of the cooling suit to be appropriately cooled. However, it has been impossible to sufficiently evaporate the exuded perspiration, when the wearer exuded a large amount of perspiration due to a work in a high temperature environment, a hard work, or the like. Namely, it has been impossible to use the conventional air-flow type cooling suits under such severe usage environments. Further, the conventional air-flow type cooling suits are each provided with spacers between the cooling suit and an undergarment so as to ensure an airflow passage. This has caused the conventional air-flow type cooling suits to be complicated in configuration.

[0006] Further, cooling suits to be used in a situation that a large amount of perspiration is exuded, are to be desirably easily washable, since such cooling suits are stained with perspiration.

[0007] The present invention has been made under the above-described circumstances, and it is therefore an object of the present invention to provide a cooling suit having a simple structure and capable of assuredly evaporating a large amount of perspiration.

[0008] In addition to the above object, it is another object of the present invention to provide a cooling suit

which is easily washable.

MEANS FOR SOLVING THE PROBLEM

[0009] To achieve the object, the invention recited in Claim 1 resides in a cooling suit to be worn on a wearer, comprising: at least one air inlet configured to introduce outside air; at least one parallel airstream generation means for introducing the outside air through the or each air inlet to generate parallel airstreams which are substantially parallel to the wearer's body; a guide sheet simultaneously serving as a garment and for guiding the parallel airstreams generated by the or each parallel airstream generation means, parallelly to the wearer's body; at least one air exit portion configured to discharge the parallel airstreams to the exterior; and electric-power source means for supplying electric power to the or each parallel airstream generation means; wherein the or each parallel airstream generation means cooperatively blows air of a total amount of about $5m^3/H$ to $500m^3/H$ into between the guide sheet and an undergarment or wearer's body to cause positive pressures between the guide sheet and the undergarment or wearer's body to thereby produce an air flow space therebetween, and the or each parallel airstream generation means causes the blown air to flow through the air flow space to thereby discharge moisture due to perspiration to the exterior and to thereby constantly feed fresh outside air into the air flow space, thereby largely

intensifying conditions where perspiration can be evaporated.

EFFECT OF THE INVENTION

[0010] The cooling suit according to the present invention is capable of causing a large amount of air to flow between an undergarment or wearer's body and a guide sheet so as to largely extend an effective area under the influence of a physiological cooling ability of the wearer to thereby cool the wearer's body.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0011] FIG. 1A is a schematic front view of a cooling suit according to a first embodiment of the present invention when it is worn, and FIG. 1B is a schematic rear view of the cooling suit.

FIG. 2 is a schematic side view of the vicinity of a parallel airstream generation device attached to a garment 2.

FIG. 3A is a schematic front view of a fan casing of the parallel airstream generation device, and FIG. 3B is a partially sectioned schematic side view thereof.

FIG. 4A is a schematic front view of a sideward-flow fan of the parallel airstream generation device, and FIG. 4B is a schematic cross-sectional view thereof viewed in a direction of arrow A-A'.

FIG. 5A and FIG. 5B are schematic cross-sectional

views showing relationships among the garment 2, a fan 3, and an undergarment 13, respectively.

FIG. 6A is a schematic front view of a cooling suit according to a second embodiment of the present invention when viewed from the front side, and FIG. 6B is a schematic rear view of the cooling suit when viewed from the back side.

FIG. 7A is a schematic front view of a fan used in the second embodiment, and FIG. 7B is a schematic side view thereof.

FIG. 8 is a schematic view of a situation where a fastener 6 of the cooling suit of this embodiment is opened to develop a fixation belt 16 having fans 3 attached thereto.

FIG. 9A is a schematic front view of a mixed-flow fan of a variant of the second embodiment, and FIG. 9B is a schematic cross-sectional view thereof viewed in a direction of arrow B-B'.

FIG. 10A is a schematic view of a third embodiment according to the present invention in a state where a fixation belt 160 of this embodiment is developed, and FIG. 10B is an enlarged schematic view of the vicinity of air inlets 2a of a garment having the fixation belt 160 attached thereto.

FIG. 11A is an explanatory plan view of a lid part in a variant of the third embodiment of the present invention, and FIG. 11B is a schematic side view thereof.

FIG. 12 is an explanatory schematic side view of a coupled state between the lid part and a fan in the variant of the third embodiment.

FIG. 13 is an explanatory view of another embodiment of the present invention.

FIG. 14 is an explanatory view of still another embodiment of the present invention.

EXPLANATION OF REFERENCE NUMERAL

[0012]

1	cooling suit
2	garment (and guide sheet)
3	parallel airstream generation device (fan)
4	air exit portion
5	air leakage prevention means
6	fastener
7a	front face fan guard
7b	internal side face fan guard
8	flange portion
8a	magic tape (attachment/detachment means)
8b	magic tape (attachment/detachment means)
9	bottom of fan casing
10	vane wheel of sideward-flow fan
10a	vane
11	motor
12	over-cooling prevention cloth
13	undergarment or wearer's body

14 suspending means

15 air permeation sheet

16 fixation belt

17 propeller

19 parallel airstream conversion plate
(parallel airstream conversion means)

20 vane of mixed-flow fan

21 string (fixation belt connection means)

32 electric power supply cord

33 electric-power source

160 fixation belt

BEST MODE FOR CARRYING OUT THE INVENTION

[0013] There will be firstly explained a cooling principle of the present invention. In a state where a large amount of perspiration is exuded by a human, concretely, where an undergarment is stained with perspiration, the humidity near the undergarment or a skin becomes approximately 100% so that perspiration to be subsequently exuded is disabled from vaporizing. Nonetheless, it is possible to cause perspiration to vaporize even when outside air is 90% in humidity, by flowing a large amount of air. Generally, temperatures are not so high when humidities are extremely high, and conversely, humidities are low when temperatures are extremely high. The temperature to be obtained by evaporation of perspiration is determined by a wet-bulb

temperature of a wet and dry bulb thermometer. For example, it is possible to lower a body temperature down to 28°C even at an atmospheric temperature of 50°C by evaporating perspiration insofar as the humidity is 20%, such that perspiration can be perfectly vaporized in most environments insofar as a sufficient amount of airstream is flowed.

[0014] From a standpoint of cooling a body by evaporation, it is possible to classify perspiration into the following three types.

(1) Immediate effect perspiration: which vaporizes simultaneously with exudation from a body to thereby immediately cool the body.

(2) Delayed effect perspiration: which is exuded from a body in a liquid state to thereby wet an undergarment, such that the perspiration fails to immediately exhibit a cooling effect even when the body requires such an effect, but the perspiration belatedly vaporizes to resultingly cool the body when airstreams are caused, for example.

(3) Ineffective perspiration: which drops from a body, and thus has no effects for cooling the body by evaporation.

When ineffective perspiration is exuded, this is a state where a physiological cooling ability is not duly exhibited such that the body temperature is continuously raised, and this state can be never continued.

[0015] When delayed effect perspiration is exuded though ineffective perspiration is not exuded, the body

temperature is repeatedly raised and returned to a normal temperature. Although there is felt mugginess and thus uncomfortableness in this state, it is not impossible to continue this state. It is due to such delayed effect perspiration, that cooling effects are felt when exposed to airstreams in a state where an undergarment is wet. Meanwhile, when only immediate effect perspiration is exuded, the perspiration is immediately vaporized without delayed cooling in a manner that the body temperature is unchanged, which is an extremely comfortable state without feeling hotness.

[0016] Hotness, coolness and the like are not absolute feelings, and are determined depending on a then movement state of a human, an atmospheric temperature, a humidity, presence/absence of airstreams, and the like, so that the human never feels hotness even when the atmospheric temperature is high insofar as all perspiration is immediate effect perspiration. As such, it is possible to convert all perspiration controlled by a brain into immediate effect perspiration by causing a lot of airstreams to flow parallelly to a wearer's body by means of a cooling suit so as to cause exuded perspiration to immediately vaporize, thereby cooling the wearer's body to an appropriate level. Namely, wearing the cooling suit and causing a large amount of air to flow parallelly to a wearer's body, enables drastic extension of a range of conditions where perspiration exuded from a wearer's body

can be evaporated.

[0017] There was conducted a practical test for an office work such that a cooling suit capable of flowing a lot of airstreams ($30m^3/H$) was worn by each wearer sitting on a cooling seat cushion of the same principle and also putting a cooling cap on his/her head. As a result, although the room temperature was raised to about 40°C as the highest, the wearer who was not so fatty did not feel at all a difference between room temperatures of 25°C and 40°C. Only, limitation temperatures where hotness was felt, varied wearer by wearer. While it is practically experienced that perspiration in a liquid state is exuded when hotness is felt, it has been rather confirmed by the test that sultriness is not felt when only immediate effect perspiration is exuded without exudation of perspiration in a liquid state. Note that airstreams parallel to a wearer's body never impinge on a wearer's body no matter how strongly the airstreams are flowed, thereby preventing a user from uncomfortable feeling which is otherwise caused when exposed to lukewarm airstreams from an electric fan.

[0018] The state, where a human feels most comfortable, is a situation where perspiration is being exuded for heat radiation and the perspiration immediately vaporizes, i.e., a situation where a physiological cooling ability (cooler) is enabled. As conditions for realizing this situation, it is required to constantly cause outside air to flow parallelly to a wearer's body to thereby

exhaust moisture to the outside, in a state where the outside air temperature is so high that perspiration is exuded.

[0019] As described above, the present invention is configured to cause a lot of airstreams to flow parallelly to a wearer's body to thereby largely extend an effective area under the influence of a physiological cooling ability even in a severe environment where ineffective perspiration is exuded.

[0020]

[First Embodiment]

There will be explained a best mode for carrying out the present invention according to the present application. There is provided a cooling suit according to a first embodiment of the present invention applied to a short-sleeved jacket of a worksuit. FIG. 1A is a schematic front view of the cooling suit according to the first embodiment of the present invention when it is worn, and FIG. 1B is a schematic rear view of the cooling suit. As shown in FIG. 1, the cooling suit 1 of the first embodiment comprises: a garment or jacket 2 formed into a shape of a short-sleeved jacket and simultaneously serving as a guide sheet (the meaning of "guide" will be described later) which is less in air leakage; parallel airstream generation devices 3 provided at the lower right and left of a back side of the garment, respectively, to introduce outside air to thereby generate airflows between the garment 2 and an undergarment

or wearer's body and parallelly to the wearer's body; air exit portions 4 serving as exits of air, respectively; air inlets 2a formed in the garment 2 and serving as inlets of air, respectively; air leakage prevention means 5 for preventing air leakage from a hemline of the garment 2; and fastener 6 for opening and closing a front portion of the garment 2.

[0021] In this embodiment, the parallel airstream generation devices 3 are provided by two in number, and arranged to suck outside air into the interior of the garment when the parallel airstream generation devices are supplied with electric power through cords (not shown), respectively, from an electric-power source or battery (not shown) detachably provided on the garment 2. Further, the total of air blowing amount of the two parallel airstream generation devices 3 is set at about $10m^3/H$. Hereinafter, the parallel airstream generation devices 3 are each simply and occasionally referred to as a fan 3. In turn, the air exit portions 4 of the cooling suit of this embodiment include a gap between a collar portion of the garment and the wearer's body, and gaps between sleeve edges and the arms of the wearer, respectively. The air leakage prevention means 5 is configured to prevent air leakage from a hemline portion of the garment, by passing a string through the hemline portion and by strongly knotting opposite ends of the string together, for example.

[0022] The first embodiment is constituted in the

above manner. Thus, driving the parallel airstream generation devices 3 introduces air of about $10m^3/H$ into the interior of the cooling suit 1 through the air inlets 2a to cause positive pressures near the parallel airstream generation devices 3 inside the cooling suit 1 to thereby bulge the garment 2 in a manner to produce a space between the garment simultaneously serving as the guide sheet and the undergarment, so that airstreams tending to embrace the wearer's body are established and the airstreams are caused to exit to the exterior through the air exit portions 4 which are end portions of the cooling suit, respectively. Here, the reason why the garment 2 has been called the guide sheet, is that the garment 2 simultaneously plays a role of a guide for forming airflows which tend to embrace the wearer's body. It is thus desirable that the garment is made from a material less in air leakage such as a tight cloth, and is devised in shape such that a lot of airflows are established.

[0023] As described above, establishing a lot of airflows parallelly to the wearer's body, enables a larger extension of an effective area under the influence of a physiological cooling ability of the wearer's body to thereby essentially solve the problem due to hotness, by virtue of the cooling suit of this embodiment.

[0024] There will be detailedly explained points in case of applying the cooling suit of the present invention to a worksuit.

Items generally required in case of application to a worksuit are:

(1) that the cooling suit is inexpensive;

(2) that the cooling suit has a larger cooling capacity;

(3) that the cooling suit does not deteriorate the workability of the worksuit; and

(4) that electrical components of the cooling suit are to be readily detached from the worksuit since the worksuit is to be washed so frequently.

Contrary, there is not so emphasized an aspect of fashion of the cooling suit, in case of application to a worksuit.

[0025] Firstly, concerning the item (1) of inexpensiveness, conventional cooling suits have each required spacers for previously producing airflow passages for establishing airflows parallel to a wearer's body, such that the spacers have a higher proportion of a total cost of the associated cooling suit. Contrary, in the cooling suit of this embodiment of the present invention, a large amount of air is caused to flow into the interior of the cooling suit to thereby form a space between a wearer's body and the cooling suit by virtue of a pressure of air, so as to flow air through the space, thereby realizing the airflow passages without using spacers.

[0026] The item (2) of the larger cooling capacity can be realized by using a large-sized fan and by further

adopting a high efficient motor for the fan. As such a motor, there is optimally adopted a brush motor, also taking account of cost. The items (3) and (4) will be described later.

[0027] The parallel airstream generation device of this embodiment will be described next. FIG. 2 is a schematic side view of the vicinity of the parallel airstream generation device attached to the garment 2. FIG. 3A is a schematic front view of the fan casing of the parallel airstream generation device, and FIG. 3B is a partially sectioned schematic side view thereof. FIG. 4A is a schematic front view of a sideward-flow fan of the parallel airstream generation device, and FIG. 4B is a schematic cross-sectional view thereof viewed in a direction of arrow A-A'.

The parallel airstream generation devices 3 of this embodiment each comprises a sideward-flow fan 3a, an over-cooling prevention cloth 12, and a fan casing 31.

[0028] As shown in FIG. 3, each fan casing 31 comprises: a front face fan guard 7a formed at an air inlet of the fan; an internal side face fan guard 7b formed at an associated parallel airstream deliver portion; a flange portion 8; a bottom 9; and a magic tape 8a attached to the flange portion 8. Although the front face fan guard 7a and the internal side face fan guard 7b are each formed of a circular column-like member in this embodiment, they may be each formed in a square column-like shape. Particularly,

since the fan having a larger air blowing capacity such as in this embodiment has a vane wheel 10 having a larger rotation energy such that fingers or the like are prevented from the contacting with the vane wheel 10, it is necessary to cover the fan by the fan guards. Further, there is frequently required a washing operation depending on a type of work, so that the flange portion is provided with the magic tape for allowing the fan to be readily attached and detached upon washing. In turn, there is provided a magic tape 8b in a donut shape at a reverse side around the associated air inlet 2a of the garment 2. Each fan 3 can be detachably attached to the garment 2 by the associated magic tape 8a provided at the air inlet of the fan 3 and the associated magic tape 8b provided at the air inlet of the garment 2. Note that the attachment/detachment means for the fans 3 are not limited to the magic tapes, and various ways are conceivable.

[0029] As shown in FIG. 4, each sideward-flow fan 3a of this embodiment comprises the vane wheel 10 and a motor 11. The vane wheel 10 comprises: a rotor 10b; and a number of vanes 10a each formed at a periphery portion of the rotor 10b in a manner to be substantially perpendicularly to a rotation plane of the rotor 10b. Thus, rotating the vane wheel 10 by the motor 11 introduces air from the front face of the vane wheel as shown by an arrow, and discharges the air in a sideward direction. In this embodiment, such a fan for delivering airstreams in this manner is called as

a sideward-flow fan.

[0030] Each over-cooling prevention cloth 12 is made of a cloth which is high in thermal insulation, and attached to the bottom 9 of the associated fan casing 31. The over-cooling prevention cloth 12 has a contour larger than that of the fan casing 31 by about 5cm to 15cm, for example. As shown by inclined arrows in FIG. 2, directions of airstreams blown by the fan 3 are not made completely parallel to the wearer's body due to reasons of inertia of sucked air and the like, and are blown onto the wearer's body around the fan. Particularly, although the cooling suit of this embodiment is required to be worn in a situation where the outside air temperature is not so high but mugginess is to be solved, it is likely that the wearer's body is partially and excessively cooled around the fan 3 where the outside air is directly blown onto the wearer's body if a temperature difference between the air and the body temperature is large. To prevent it, provided in this embodiment is the over-cooling prevention cloth 12 made of a cloth which is high in thermal insulation, for example.

[0031] Further, the cooling suit 1 of this embodiment is provided with suspending means 14. FIG. 5A and FIG. 5B are schematic cross-sectional views showing relationships among the garment 2, the fan 3, and the undergarment 13, respectively. The suspending means 14 of this embodiment has one end attached to a shoulder portion of the garment 2,

and the other end attached to the associated fan. Since the fan 3 having a larger air blowing capacity is heavy, the fan 3 is inclined as shown in FIG. 5A when it is attached to the garment by the magic tapes only, thereby not only deteriorating the external appearance but also deteriorating the function itself of the cooling suit. Thus, each fan 3 in this embodiment is suspended from the above such as an upper portion of the garment 2 by the suspending means 14 such as a string, as shown in FIG. 5B. Note that this string may be in a round rod shape or a strip shape.

[0032] According to this embodiment, a lot of airstreams of about $10m^3/H$ blown into between and parallelly to the undergarment 13 and the garment 2 by the parallel airstream generation devices 3, cause positive pressures in the space between the garment 2 and the undergarment to thereby bulge the garment to automatically produce airflow passages between the garment and the undergarment, and the airstreams are exhausted to the exterior through the air exit portions 4 formed at the ends of the garment. In this way, since the cooling suit of this embodiment is capable of producing airflow passages without using spacers for ensuring the airflow passages, the structure of the cooling suit is simplified and can be fabricated inexpensively.

[0033] Further, it is certainly possible to cause air to flow even by an airstream amount of about $5m^3/H$ without

using spacers by devising a configuration of the garment, an air resistance at each air exit portion, a weight of the garment, and the like. However, in such a case, it is rather desirable to more assuredly ensure airflow passages by using small spacers at important locations, respectively, from a standpoint of cost and cooling capability. Usable as spacers in this case are sponge-made ones or the like, for example. Further, the upper limit of a total air blowing amount by the parallel airstream generation devices is about $500m^3/H$. Upper limits exceeding it lead to more large-sized parallel airstream generation devices to thereby deteriorate the workability, which is impractical. Note that the reason why the garment has been called the "guide sheet", is that the garment itself simultaneously plays a role for guiding parallel airstreams generated by the parallel airstream generation devices up to the air exit portions 4 acting as air exits, while keeping the airstreams parallel to the wearer's body. As the conditions therefor, it is enough to only adopt a material less in air leakage for a garment in a manner to readily produce a space between an undergarment and the garment by a small pressure. Further, it is not absolutely necessary to cause air to flow along the entirety of the wearer's body covered by the garment, and it is enough to devise the shape of the garment or the like such that air is concentratedly flowed along portions where perspiration apts to be exuded. Particularly, it is generally said that

a belly is not to be cooled so much. The air leakage prevention means 5 constituted at the hemline is required to prevent air leakage from the hemline and to exhaust all the airstreams blown from the lower portion of the back side, through the air exit portions 4 acting as air exits formed at end portions, after passing through the back side, chest, armpits, and the like. However, the air leakage prevention means may be omitted depending on an attached position of the parallel airstream generation device, a purpose of use of the cooling suit itself, and the like.

[0034]

[Second Embodiment]

There will be explained a second embodiment of the present invention with reference to the drawings. The second embodiment is applied to a worksuit having a cooling capacity higher than that of the cooling suit of the first embodiment. The second embodiment has an air blowing capacity of about $20m^3/H$ which is two times that of the first embodiment. The second embodiment is differentiated from the first embodiment, because, in the second embodiment: there is adopted a propeller as vanes of each parallel airstream generation device, instead of a vane wheel; there is provided a new air exit portion provided with an air permeation sheet, as an exit of air; and there is provided a fixation belt as fixation means for preventing a large fan from being swung due to a movement of a wearer's body. Other configuration is the same as

that in of the first embodiment. Thus, like reference numerals as used in the first embodiment are used to denote elements of the second embodiment having the same functions as the first embodiment, and the detailed description thereof will be omitted.

[0035] FIG. 6A is a schematic front view of the cooling suit according to the second embodiment when viewed from the front side, and FIG. 6B is a schematic rear view of the cooling suit when viewed from the back side. Attached to an upper portion of a back side of the cooling suit of this embodiment, is an air permeation sheet 15 which is a cloth having a larger air permeability instead of a cloth of a garment, such that also the attached portion becomes an air exit portion 4. In the following, such an air exit portion 4 in the second embodiment is called a "second air exit portion", and each air exit portion 4 as in the first embodiment is called a "first air exit portion", so as to distinguish them from each other.

[0036] FIG. 7A is a schematic front view of each fan used in the second embodiment, and FIG. 7B is a schematic side view thereof. Each fan of the second embodiment is different from that of the first embodiment, in that the former adopts a propeller 17 instead of the vane wheel for vanes used in the latter. The propeller 17 is rotated by a motor 11 in a direction to introduce outside air, in a manner to introduce the outside air and to feed airstreams perpendicularly to a rotation plane of the propeller.

However, the airstreams impinge on a parallel airstream conversion plate (parallel airstream conversion means) 19, and are converted into a direction parallel to the rotation plane of the propeller as shown by lateral arrows so that the airstreams are made parallel to a wearer's body. Note that the bottom 9 of a fan casing simultaneously serve as the parallel airstream conversion plate 19 in this embodiment. Further, there is provided an over-cooling prevention cloth 12 (not shown) also in this embodiment.

[0037] Here, required between a lower end of the propeller and the parallel airstream conversion plate 19 is a spacing "H" which is about 1/5 times a diameter of the propeller, and spacings less than it lead to considerably reduced air blowing amounts. At the minimum, there will be required 1/10 times. Although this leads to an increased thickness of the fan as compared with the sideward-flow fan used in the first embodiment, there is provided an advantage that the same airstream amount as the sideward-flow fan is generated by a power consumption smaller than that of the sideward-flow fan. Note that the spacing "H" may be set at zero depending on the usage, such as when a small amount of airstream will do.

[0038] FIG. 8 is a schematic view of a situation where the fastener 6 of the cooling suit of this embodiment is opened to spread the fixation belt 16 having fans 3 attached thereto. The fixation belt 16 of this embodiment is provided for attaching the two fans 3 to the wearer's

body in a closely contacted manner. Note that an electric-power source or battery (not shown), cords, and the like are detachably attached to the garment similarly to the first embodiment. The fixation belt 16 has opposite ends each having a string 21 attached thereto acting as fixation belt connection means. The cooling suit of this embodiment requiring a larger cooling capacity requires larger fans so that the weight of fans is also increased. Attaching large and heavy fans to the garment 2 not only causes the fans to be inclined to thereby deteriorate the capabilities thereof, but also swings the fans to deteriorate the workability when the user moves around. The fixation belt 16 is provided as a countermeasure thereto, in a manner to cause the fans 3 to be closely contacted with the wearer's body to solve the above-described problem. Note that the fixation belt 16 may be fixed to the garment 2 at several locations, or may be made free from the garment 2 without being fixed thereto. Even when the fixation belt 16 is made free, the fans are fixed to the garment by magic tapes of the fans.

[0039] FIG. 9A is a schematic front view of a mixed-flow fan of a modification of the second embodiment, and FIG. 9B is a schematic cross-sectional view thereof viewed in a direction of arrow B-B'. Note that the fan casing 31 is omitted in FIG. 9B for simplification. This modification is configured to use vanes 20 of a mixed-flow fan, instead of a propeller. The structure of the vanes of

the mixed-flow fan is intermediate between those of a sideward-flow fan and a propeller fan, and is intermediate also in property, in a manner to introduce air from its front face as indicated by vertical arrows shown in FIG. 9 and to deliver the air in an obliquely rearward direction. There is thus required a spacing "H" between the lower portions of the vanes and the parallel airstream conversion plate even when adopting this type of vanes. However, the length of the required spacing "H" is made large when the vane shape is analogous to that of a propeller, and is made small when the vane shape is analogous to a vane wheel. Note that the spacing "H" may be set at zero also in this case depending on the usage, such as when a small amount of airstream will do.

[0040] Upon using the cooling suit of this embodiment, arms are passed through the sleeves, respectively, then the strings 21 attached at the front ends of the fixation belt 16 are knotted together before the fastener 6 is closed to thereby fix the fans to the wearer's body, and thereafter the fastener is closed. Of course, the connection means of the fixation belt 16 is not limited to the strings, and magic tape or the like may be used.

[0041] According to this embodiment, airstreams blown into the interior of the garment (guide sheet) by the parallel airstream generation devices are guided by the guide sheet parallelly to the wearer's body and exhausted to the exterior through the air exit portions acting as air

exits, respectively, in the same manner as the first embodiment. In this embodiment, a part of the upper portion of the back side of the garment is substituted by the air permeation sheet, thereby becoming the second air exit portion in addition to the first air exit portions. It is typical and frequent that a collar portion of a worksuit or the like has a front portion which is to be largely opened and a rear portion which is to be closely contacted with a neck of a wearer. In such a configuration, the collar portion of the worksuit is insufficient at the rear portion thereof in function as an air exit portion, so that airflows are not so established at an upper portion of the back side of the wearer. To aid it, the part of the cloth of the garment at the upper portion of its back side is substituted by the sheet which has an excellent air permeability to thereby cause the part to function as an air exit portion, thereby enabling improvement of an airstream amount at the upper portion of the back side. Other functions and effects of this embodiment are the same as those of the first embodiment.

[0042]

[Third Embodiment]

There will be explained a third embodiment of the present invention. The third embodiment is different from the first embodiment and second embodiment, in that the former includes a fixation belt having not only fans but also an electric-power source (battery), cords and the like,

attached thereto. Other points are the same as those in the second embodiment. Thus, like reference numerals as used in the second embodiment are used to denote elements of the third embodiment having the same functions as the second embodiment, and the detailed description thereof will be omitted. FIG. 10A is a schematic view of this embodiment in a state where the fixation belt 160 of this embodiment is developed. The fixation belt 160 of this embodiment has a width larger than a diameter of each fan 3, and has two fans 3, electric power supply cords 32, and an electric-power source 33 detachably attached to the belt. Thus, the fixation belt 160 can be regarded as an item realized by eliminating a guide sheet (garment) from a cooling suit. FIG. 10B is an enlarged schematic view of the vicinity of air inlets 2a of a garment having the fixation belt 160 attached thereto. Provided around the air inlets 2a are magic tapes 8b in donut shapes, respectively. Also provided at flange portions 8 of the fans 3 are magic tapes 8a, respectively, in the above-described manner. The fixation belt 160 of this embodiment is attached to the garment by joining the magic tapes 8a of the fixation belt 160 to the magic tapes 8b of the garment, respectively, in a closely contacted manner.

[0043] According to this embodiment, detaching the fixation belt 160 from the garment allows the fans, electric-power source, and cords to be simultaneously detached without a burden, such as when the cooling suit is

to be washed. Further, this embodiment is substantially the same in configuration as the second embodiment insofar as the fixation belt 160 is attached to the garment 2, and the manner for wearing the garment 2 is the same as the second embodiment. The third embodiment has its most remarkable advantage in that the electrical components can be collectively and readily attached and detached upon washing as described above. Further, since all the electrical components are fixed onto the belt, handling is facilitated with less trouble. Note that the fixation belt 160 is to be desirably fabricated from a material which rarely gets dirty and is readily wiped down even when it gets dirty, since the fixation belt itself should not be washed. Particularly preferable is a material which does not absorb perspiration, and it is desirable to perform an antifungal process thereto. Further, attachment and detachment of the fixation belt to and from the garment 2 are not limited to the method by magic tapes, and any method will do insofar as a large air leakage is absent between the fans attached to the fixation belt and the garment. Moreover, the functions and effects of this embodiment are the same as those of the second embodiment.

[0044] Examples of fans to be attached onto the fixation belt include one having a front face fan guard, and one without a front face fan guard while forming the front face fan guard at the side of a garment. In this case, it is possible to apply a mesh or the like across an

air inlet 2a of a garment, for example, instead of a front face fan guard. Further, as shown in FIG. 11, it is also possible to attach a fixation belt 160 onto a garment, in a manner to: fabricate a lid part 200 comprising a lid-oriented fan guard 201, a flange portion 202, and a cylinder portion 203 in a tapered shape as shown in FIG. 11; and to fit the cylinder portion 203 of the lid part 200 into an inside of the flange portion of the fan 3 as shown in FIG. 12 to thereby clamp the garment around the air inlet 2a between the flange portion 202 of the lid part 200 and the flange portion 8 of the fan 3 in a manner to couple the lid part 200 to the fan 3. Note that the coupling method of the lid part and the fan is not limited to the above method, and any coupling method will do insofar as the fixation belt 160 can be attached to the garment by clamping the garment between the lid part and the fan. Further, vanes within the fan casing are omitted in FIG. 12 for simplification.

[0045]

[Other Embodiments]

The present invention is not limited to the above embodiments, and many variants are possible within the scope of the gist of the present invention. For example, although the above embodiments have been each described for a situation where the cooling suit is a jacket for working, the present invention may be embodied as a cooling suit which is a pair of overalls including a jacket integrally

formed with trousers shown in FIG. 13, for example. In this case, also gaps between hemlines of the overalls and the feet become air exit portions 4, respectively. Further, since this embodiment comprises the overalls, there is unrequired air leakage prevention means 5.

[0046] Although the above embodiments are each provided with the fastener 6 for opening and closing the associated garment, the present invention is not limited thereto and any method will do insofar as the same provides less air leakage. Contrary, it is possible to allow air leakage to a certain extent, so as to utilize an opening and closing portion of a garment as one of air exits (for example, buttons are used instead of a fastener).

[0047] Furthermore, in case of adoption of the propeller fan as the parallel airstream generation device as described in the second embodiment, the thickness of the propeller can be reduced by increasing the number of vanes, such that the fan is not necessarily attached to an inside of a garment and may be attached to an outside of the garment when the entirety of fan is made small in thickness.

[0048] In case of adopting vanes of the propeller or mixed-flow fan, the parallel airstream conversion plate as the parallel airstream conversion means has been provided at a position separated from the lower end of the vanes by the spacing "H". However, the parallel airstream conversion means is not limited to the plate-like shape, and is rather desirably formed into a 3-dimensional shape

capable of smoothly converting an airstream direction, such as a parallel airstream conversion plate 190 in a substantially conical shape as shown in FIG. 14, for example. Further, it is unnecessary to provide a parallel airstream conversion plate or the like insofar as a spacing "H" is formed between a propeller or the like and an undergarment, and then the wearer's body or undergarment plays the same role as a parallel airstream conversion plate. In other words, the formation itself of the spacing "H" can be regarded as the parallel airstream conversion means. It is further possible to automatically form a spacing "H" by a pressure of airstream to be blown onto a wearer's body, even without previously providing the spacing "H". In this case, the parallel airstream conversion means is to be formed by the garment and the fan(s).

[0049] Further, the shape of the cloth is not limited to those which fasten in front such as described in the above embodiments, and may be a T-shirt or the like. In case of a T-shirt, air exit portions are to be provided by a collar portion, sleeves, and hemline of the T-shirt.

[0050] The guide sheet (garment) may have a certain air permeability depending on a purpose, insofar as sufficient parallel airstreams can be flowed by a fan(s) providing a larger air blowing amount. In this case, since pressures are particularly increased in an area around the fan(s), the effect thereof is improved by providing a guide

sheet (garment) having a smaller air permeability in such an area only. Meanwhile, in case of a long-sleeved cooling suit, it is likely that parallel airstreams are not flowed deeply into sleeves depending on a shape of the cooling suit. In this case, it may be sometimes desirable to adopt a cloth having a due air permeability, since airstreams will then impinge on arms when the arms are moved.

[0051] Moreover, the electric-power source means is not limited to a battery, and may be a commercial-power supply. For example, it is possible to supply electric power to the cooling suit of the present invention having its cord kept connected to a commercial-power supply, such as when a wearer works in a state sitting on substantially the same position.

INDUSTRIAL APPLICABILITY

[0052] According to the present invention as described above, it becomes possible to cause a large amount of air to flow parallelly to a wearer's body so as to largely extend an effective area under the influence of a physiological cooling ability of the wearer to thereby assuredly cool the wearer's body even in a situation where a large amount of perspiration is exuded. It is thus possible to apply the present invention to a cooling suit to be used for cooling a wearer's body in a situation where a large amount of perspiration is exuded.